27 May 1968

3812

Materiel Test Procedure 6-2-206
Electronic Proving Ground

U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST

NAVIGATION EQUIPMENT, DOPPLER

1. OBJECTIVE

The objective of this materiel test procedure (MTP) is to present test methods for use in evaluating the technical performance of doppler navigation equipment.

2. BACKGROUND

Doppler navigation systems represent a great advance over earlier types of aircraft navigation equipment. They are independent of surrounding conditions, perform with high accuracy over land and sea anywhere in the world, and are independent of ground-based navigation aids. Since military aircraft cannot depend on ground-based navigation aids (which are essentially the solution to the navigational problem for other types of aircraft) doppler navigation is the solution to the navigational problem from the military point of view. To evaluate a doppler navigator set, certain tests have to be performed to ensure that the performance of the equipment meets applicable criteria.

3. REQUIRED EQUIPMENT

The requirements for facilities and test equipment are:

a. Microwave power meter
b. Test harness
c. Flight simulators
d. Directional coupler
e. Frequency meter
f. Aircraft
g. Data recorders
h. Precision power meter
i. Field intensity meter
j. Vacuum-tube-voltmeter
k. Ruler (170 inch capabilities)
l. Scales (±1% of unit to be weighed)
m. HF Signal generator
n. Oscilloscope
o. 50-ohm dummy dual mixer
p. Vehicle with calibrated speedometer
q. Ground based cameras
r. Multiple channel recorder
s. Ground radar

4. REFERENCES

A. Automatic Doppler Navigation, General Precision Lab., Inc., Pleasantville, New York, 1963
B. Automatic Navigator AN/APN-67 (XN-1) Manual, Ryan Aeronautical Co, San Diego, California, 1954
C. Berger, Dr. France B., Doppler Air Navigation Technical Series, Volumes I, II, and IV, General Precision Lab., Inc., Pleasantville, New York.
D. Doppler Navigation Set AN/ASN-64, Technical Manual, Canadian Marconi Co., Montreal, Canada.
E. MTP 6-2-507, Safety

5. SCOPE

5.1 SUMMARY

This test procedure describes the tests required to determine and evaluate the technical characteristics and technical performance of doppler navigation equipment. Tests include the following:

a. Radio Frequency Interference - The objectives of this subtest are to determine whether electromagnetic radiation from other equipment installed near the test item interferes with the operation of the test item and to measure conducted and radiated RFI as well as susceptibility.

b. RF Power Output - The objective of this subtest is to determine the power delivered to the antenna meets applicable criteria.

c. Frequency Stability - The objective of this subtest is to determine the frequency stability of the transmitted signal from the doppler system.

d. Hover - The objective of this subtest is to determine the capability of the hover circuitry display to measure and present heading and drift velocities in accordance with applicable criteria.

e. Accuracy - The objective of this subtest is to determine the accuracy with which the system can measure and display distance traveled along true ground track. Another objective is to determine the accuracy with which the system can measure and present an electrical output proportional to drift angle.

5.2 LIMITATIONS

This MTP will not include doppler optical navigation systems, nor does it cover those tests involving environmental or servicebility these tests can be conducted by referring to the appropriate MTP.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Test Item and Test Equipment Records

The following information shall be recorded:

a. Nomenclature, serial number(s), manufaturer's name, and function of item under test

b. Nomenclature, serial number, accuracy tolerances, calibration requirements, and last day of calibration of the electronic test equipment

c. Operating hours of item under test

6.1.2 Knowledge of Technical Requirements

Test personnel shall be familiar with the required technical and operational characteristics of the item under test, such as stipulated in Qualitative Materiel Requirement (SDR), and Technical Characteristics (TC).

6.1.3 Instructional Material

Instructional material issued with the test item by the manufacturer, contractor, or government shall be readily available for reference by test personnel. Test personnel shall be familiar with the contents of such documents prior to start of tests.

6.1.4 Inspection of Equipment

Before commencement of tests, the test item shall be thoroughly inspected for obvious physical and electrical defects such as cracked or broken parts, loose connections, bare or broken wires, loose assemblies, bent fragile parts, and corroded plugs and jacks. All defects shall be noted and corrected before proceeding with the test. The equipment should be further inspected in accordance with MTP 6-2-507, Safety to determine what if any safety hazards exist.

6.2 TEST CONDUCT

All tests shall be made under the guidance of procedures contained in this MTP. Modifications to these procedures shall be made as required by technical design of the test item and availability of test equipment, but only to the extent that such modified procedures will not affect the validity of the test results.

6.2.1 Radio Frequency Interference

Radio frequency interference measurements shall be performed in accordance with MIL-STD-461, 462, and 463.

6.2.2 RF Power Output

a. This test shall consist primarily of determining the transmitter power delivered to the antenna. This shall be accomplished by connecting a microwave power meter between the transmitter output and antenna system by means of a directional coupler. (See Figure 1.)

b. The test procedure shall be as follows:

1) Set up the equipment in the laboratory
2) Connect a directional coupler to the waveguide between the transmitter and the antenna system
3) Connect the output of the directional coupler to a calibrated microwave power meter
4) Turn on system and allow for warm-up time
5) Read the power output on the power meter
6) Repeat the test at least three times and compare readings

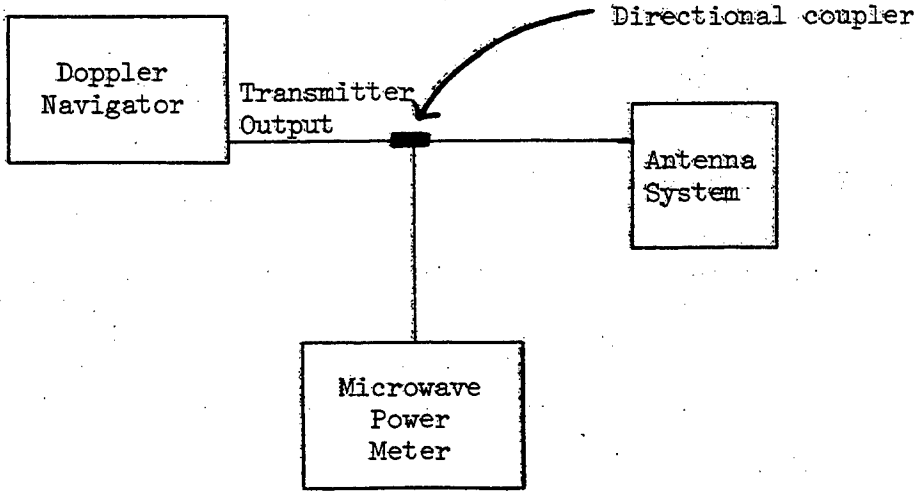

Figure 1.

6.2.3 Frequency Measurements and Frequency Stability Test

a. The primary purpose of this test shall be to determine the stability of the transmitted signal from the doppler system. This shall be accomplished by connecting a calibrated precision frequency meter between the transmitter output and the antenna system by means of a directional coupler. (See Figure 2.)

b. The test procedure shall be as follows:

1) Set up the equipment in the laboratory.
2) Connect a directional coupler to the waveguide between the transmitter and the antenna system.
3) Connect the output of the directional coupler to a calibrated precision frequency meter.
4) Turn on the system and allow for warm-up time.

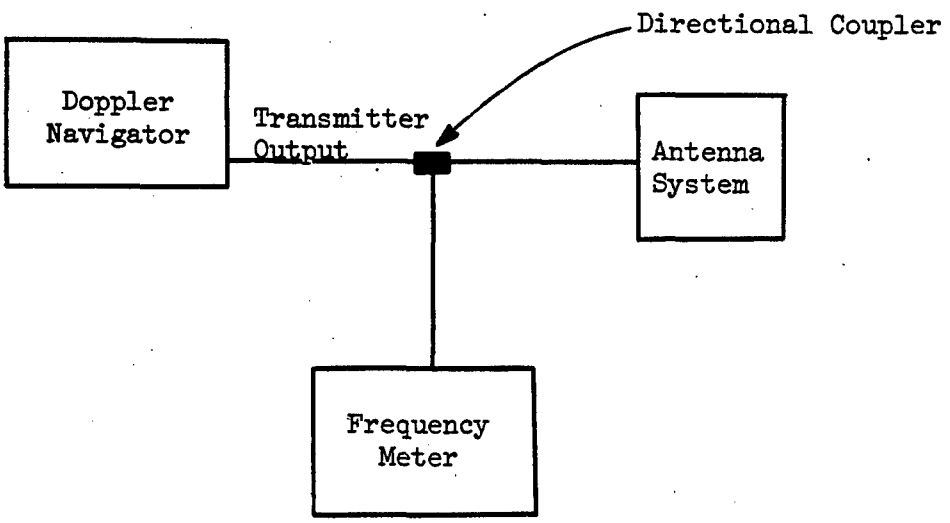

Figure 2.

5) Turn on the frequency meter to the system's transmitter frequency
6) Read the indicated frequency reading on the frequency meter
7) Repeat step 6 at prescribed intervals for a prescribed period (e.g., at five minute intervals for a period of two hours)

6.2.4 Hover Capability

a. This test shall be performed if the Doppler Navigator has hover display capabilities.

b. The test shall consist of determining the capability of the hover circuitry display to measure and present heading and drift velocities. The hover display is normally activated when the aircraft's speed decreases to a particular point. The test shall consist of:

1) Determining this point
2) Flying the Doppler Navigator below and above this velocity to cause the hover indicator to become activated and deactivated
3) Reading the hover indicator scales each time the indicator is activated or deactivated

c. The accuracy of the groundspeed components shall be tested. A ground vehicle with calibrated speedometer shall be used as a reference, and the aircraft shall follow the vehicle at matching speeds. The aircraft shall be flown so that its velocities are measured in all four quadrants of the hover indicator.

d. The following procedures shall be performed:

1) Select a suitable road for this test
2) Calibrate the ground vehicle's speedometer
3) Mount the Doppler Navigator system on the test aircraft
4) Perform normal pre-flight checks on the Doppler Navigator system
5) Fly the aircraft at matching speeds with the ground vehicle
6) Go faster and slower than the hover activation and deactivation speed several times.
7) Read the hover indicator scales each time
8) Repeat steps 5,6, and 7 at 90 degrees, 180 degrees, and 270 degrees from the heading of the first test

6.2.5 Accuracy

a. This test shall determine the accuracy with which the system can measure and display distance traveled along true ground track, and the accuracy with which the system can measure and present an electrical output proportional to drift angle.

b. The test procedure shall be as follows:

1) For true ground track accuracy measurements:

a) Select a road and accurately and plainly mark a length not less than 30-50 miles between two checkpoints
b) Mount the Doppler Navigator on the test aircraft
c) Perform normal pre-flight checks on the Doppler Navigator System.
d) Disconnect the heading reference signal
e) Supply a fixed true track ground signal
f) Fly the Doppler Navigator over the pre-marked test course
g) Observe Doppler Navigator system's present-position when aircraft flies over the test course markings

2) For Drift Angle accuracy measurements:

a) Select a strip of terrain of predetermined length within range of ground-based, fixed cameras

b) Mount the Doppler Navigator on the test aircraft
c) Perform normal pre-flight checks on the Doppler Navigator system
d) Set a multi-channel recorder for operation on board the test aircraft
e) Instrument the system to record the d-c analog voltage of drift angle on the recorder
f) Synchronize the timing pulses of the recorder and the ground-based cameras
g) Fly the Doppler Navigator with little or no inidcated drift angle over the pre-selected strip of terrain
h) Photograph the aircraft's actual yaw angle, as required

6.3 TEST DATA

6.3.1 Radio Frequency Interference Tests

Data indicated by MIL-STD-461, 462, and 463 shall be recorded.

6.3.2 RF Power Output Tests

Record the reading on the power meter.

6.3.3 Frequency Stability

Record in tabular form the frequency readings at the prescribed intervals for the prescribed time period.

6.4.3 Hover Capability Tests

a. Record ground vehicle's type and number and speedometer calibration date.
b. Record aircraft's type and number.
c. Enter names of ground vehicle's driver and aircraft's pilot.
d. Record hover system activate and deactivate speed.
e. Record compass heading and locations.
f. Record groundspeed components after each test.

6.3.5 Accuracy

a. Record aircraft's type and number.
b. Enter name of aircraft's pilot.
c. Enter road location and distance between checkpoints.
d. Record distance traveled as indicated by the item under test.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Radio Frequency Interference Tests

Data collected in accordance with paragraph 6.3.1 shall be reduced and presented in suitable form.

6.4.2 RF Power Output Tests

Compare the recorded RF power output data to the system's required specification.

6.4.3 Frequency Stability

a. Present the tabulated data in a frequency versus time plot.
b. Compare results with requirements or specifications.
c. Ascertain that radar operating frequency is within the spectrum allocated for radar doppler navigation.

6.4.4 Hover Capability

a. Compare the system's activate and deactivate speeds to the required specifications.
b. Compare the ground speed components display capability and accuracy to applicable specified requirements.

6.4.5 Accuracy

Compare the system's true ground track and drift angle accuracy to applicable specified requirements.